





OBSERVATIONS OF ENVIRONMENTAL VARIABILITY WITH TACTICAL IMPLICATIONS

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Airlie House

Warrenton, VA

OUTLINE

- OBJECTIVES
- FOM DEFINITION
- ENVIRONMENTAL VARIABILITY OBSERVATIONS
 - Surface Duct
 - TL and Ambient Noise Fluctuations: Effects of Bottom Interaction on East China Sea and Sea of Japan
 - Mesoscale Oceanography Effects: Shelf Break Primer
- SUMMARY

OBJECTIVES

Present Examples From Naval Exercises In Littoral Showing Environmental Variability And Impact On Tactical Sonar System Performance

Figure of Merit Definition

$$SE = SL - TL - NL + AG - 10 \log b - DT$$

where: SE = Signal Excess

 $SL = Target Source Level, dB re 1\mu Pa/Hz @ 1m$

TL = Transmission Loss from target to receiver, dB re 1m

 $NL = Ambient Noise Level, dB re 1\mu Pa/Hz$

b = bandwidth, Hz

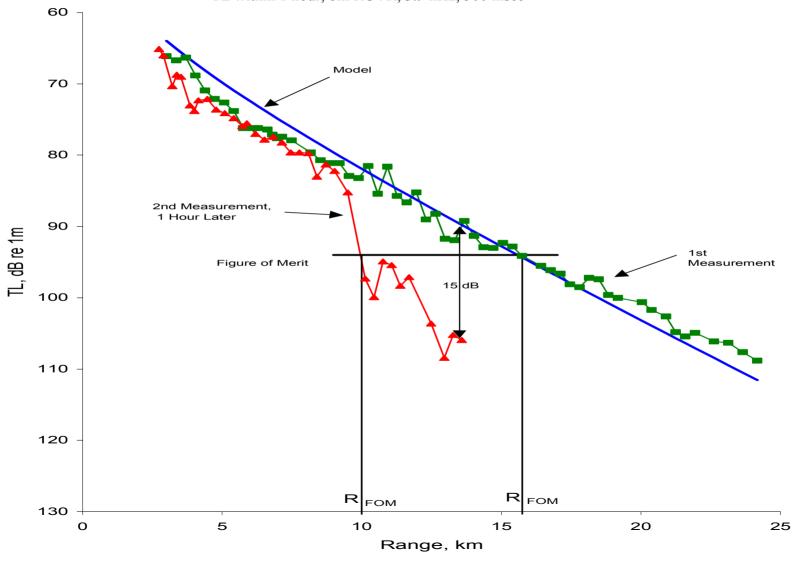
AG = Array Gain, dB

DT = Detection Threshold for 50% Probability of Detection, dB

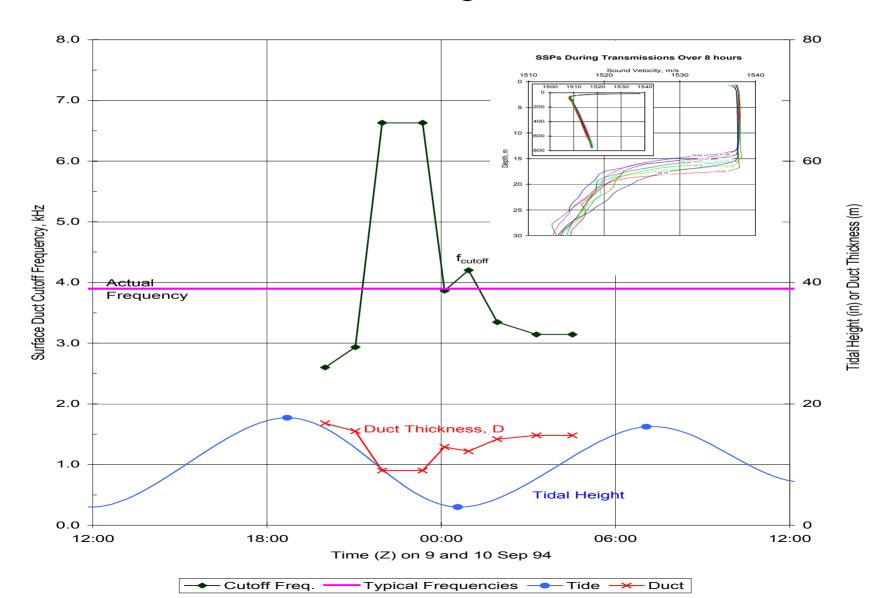
Figure of Merit (FOM) =
$$TL_{SE=0dB}$$
 = $SL-NL + AG - 10 log b - DT$

Littoral Surface Duct Transmission Cut-Off Due to Internal Waves

TL within 1 hour, 8m RCVR, 3.9 kHz, 500 msec

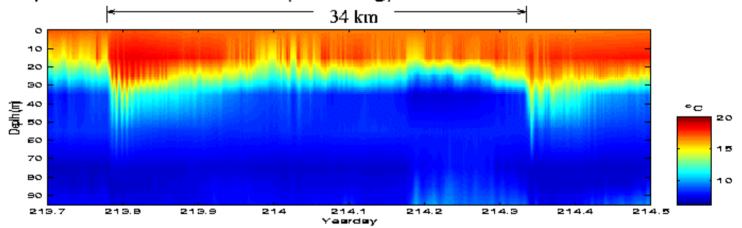


Surface Duct Thickness, Cut-Off Frequency and Tidal Height vs. Time

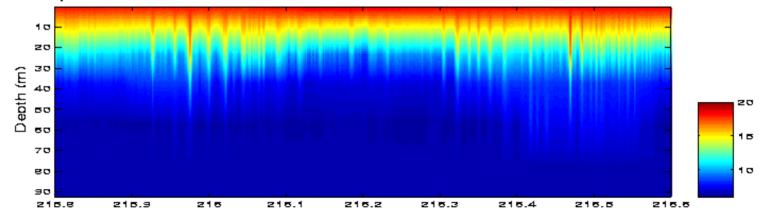


SOLITONS AND THE SOLIBORE INTERNAL TIDE FROM SHELF BREAK PRIMER DATA - SUMMER

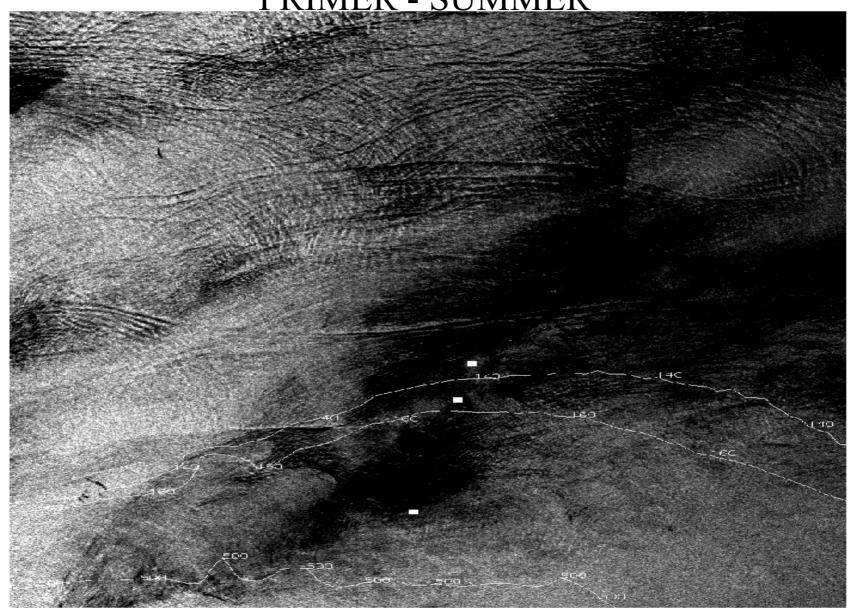
Example from western side (O-String)



Example from NE VLA Thermistors

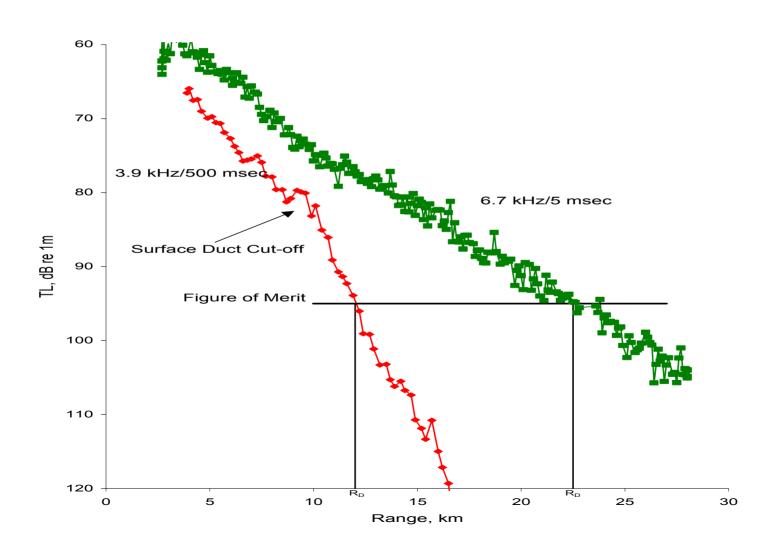


INTERNAL WAVES FROM SHELF BREAK PRIMER - SUMMER



TL for Signals Radiated Simultaneously from 2 Sonar Ships (Side-by-Side)

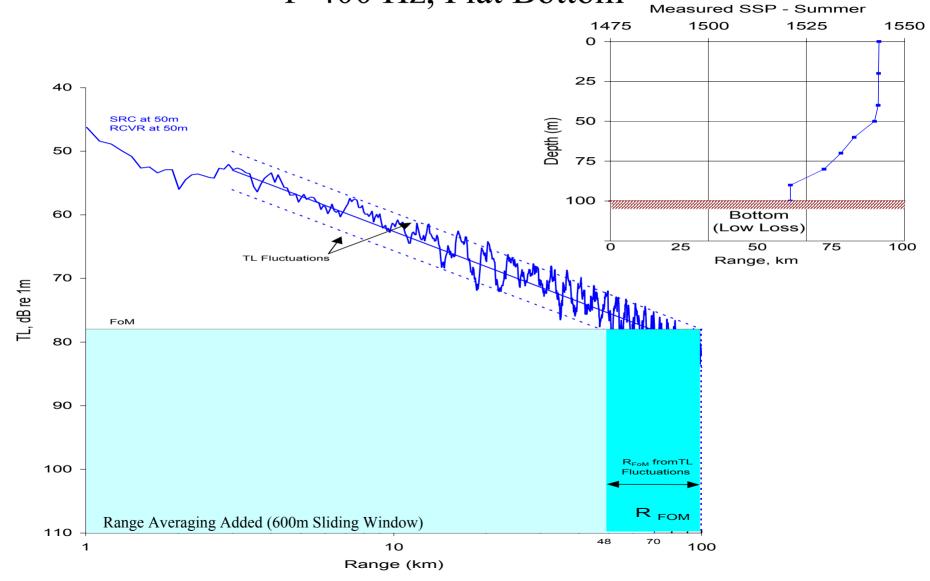
8m RCVR Gulf of Oman in Summer

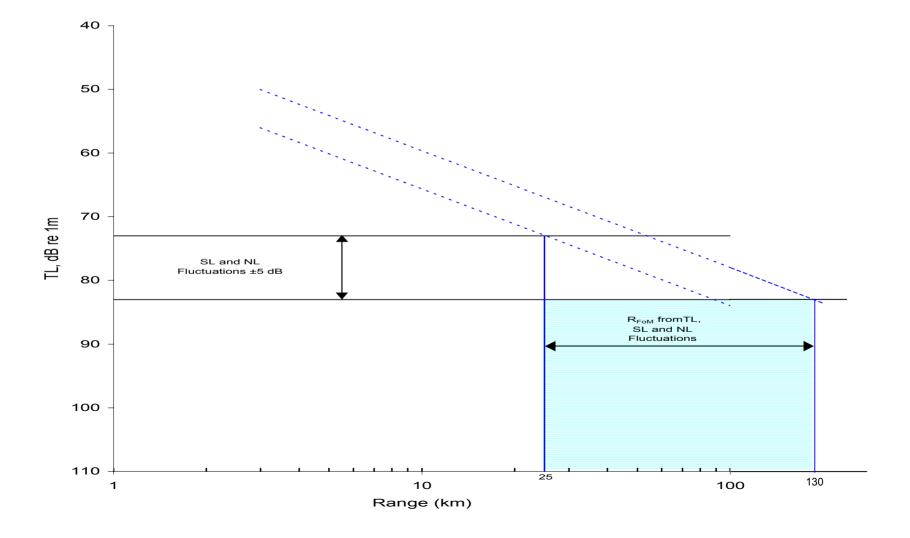


OBSERVATIONS: SURFACE DUCTS

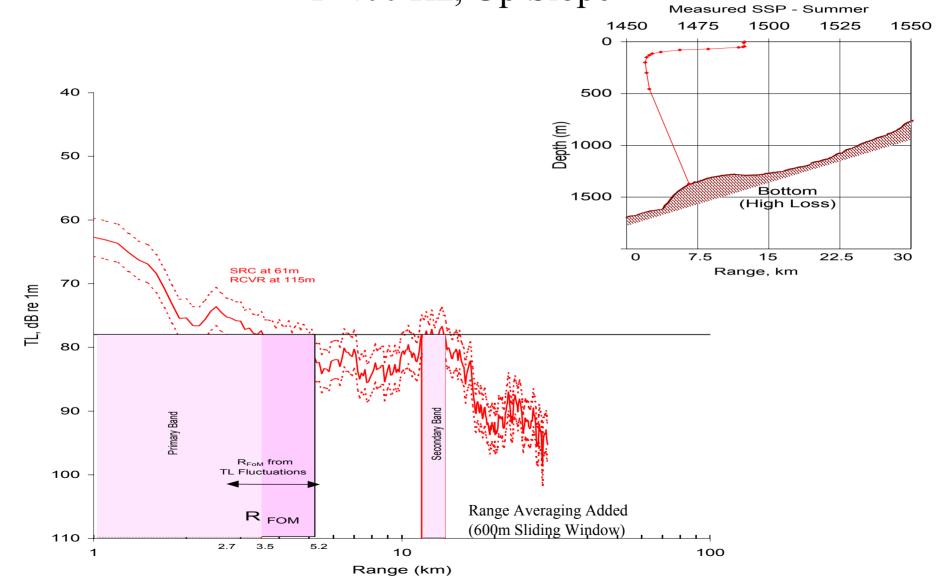
- Temporal and Spatial Complexities from Internal Waves Cause Significant Variability in Surface Duct FOM Range
- Tactical Implication:
 - Some Detection Directions Better Than Others
 - Some Detection Times Better Than Others
 - Frequency Dependent

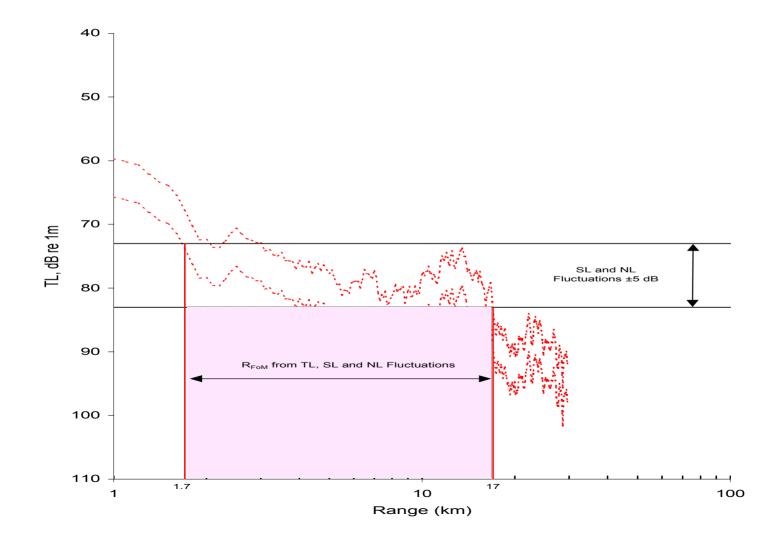
Modeled TL in the East China Sea f=400 Hz, Flat Bottom





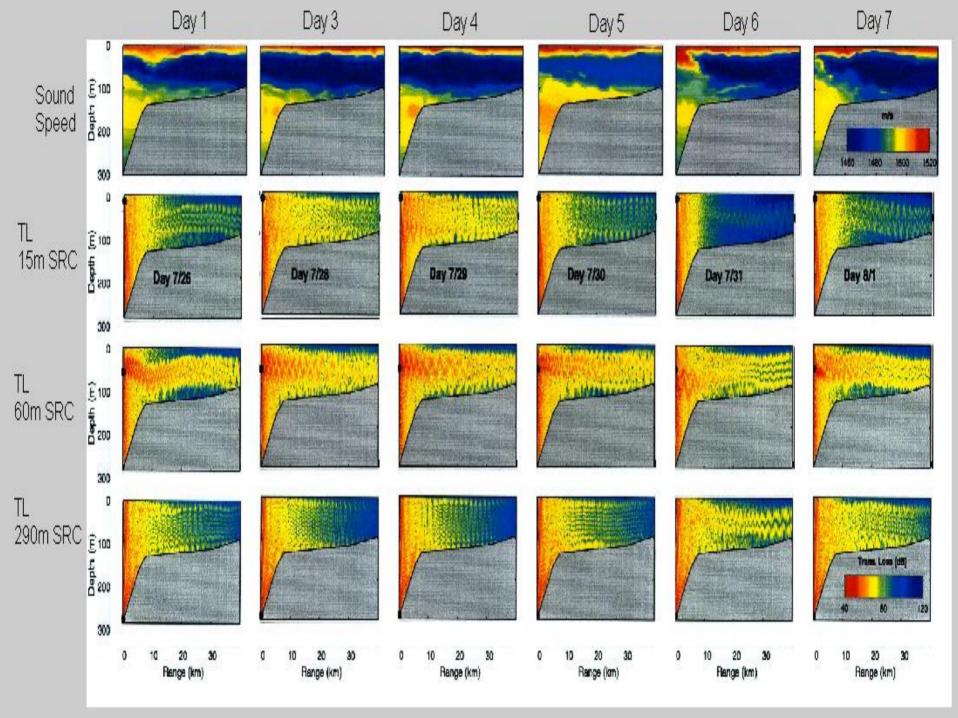
Modeled TL in the Sea of Japan f=400 Hz, Up Slope



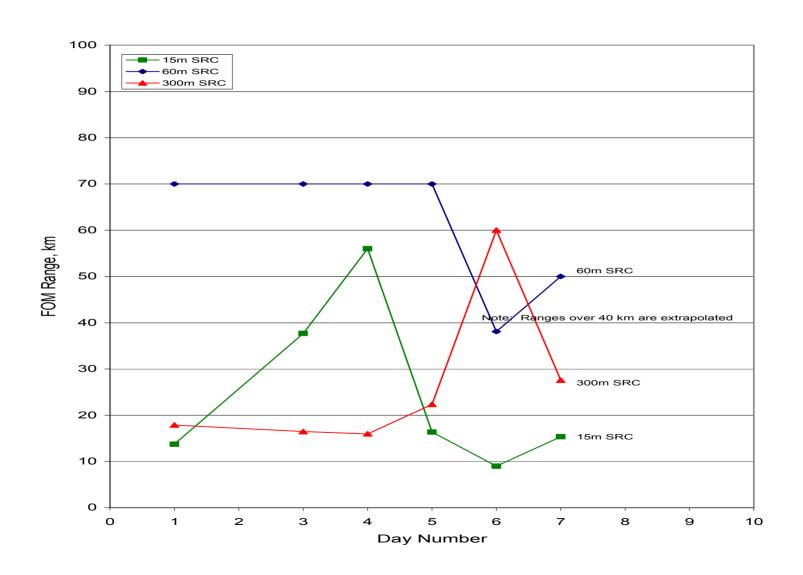


OBSERVATIONS: TL, SOURCE LEVEL AND AMBIENT NOISE FLUCTUATIONS

- TL Fluctuations Result in FOM Range Variability
- NL and SL Fluctuations Result in Significant FOM Range Variability
- How Do Present TDAs Account for Such Variability?



Shelf Break Primer FOM Range vs. Day 15m, 60m, 300m SRC, 75m RCVR



OBSERVATIONS: MESOSCALE VARIABILITY FROM SHELF BREAK PRIMER

- Significant Changes in Day-to-Day FOM Range
- Tactical System Performance Affected by Environmental Variability

Temporal and Spatial Variability in Littoral Environment Dramatically Impacts Tactical Sonar System Performance

FUTURE DIRECTIONS

- Environmental Variability IS Important in Tactical System Mission Planning and Operation in these Environments
 - Mission-Specific FOMs Should Be Used
 - Sampling Strategies
 - Rules-of-Thumb/TACMEMOS
- Variability in Tactical Decision Aids Should Include PDFs of all FOM Terms